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CLAIMS

(57) [Claim(s)]
[Claim 1] In the optical transmission device which changes and multiplexes the second different signal from the amplitude-modulated signal by which frequency multiplex was carried out, and this to a lightwave signal A modulation conversion means to bundle up said amplitude-modulated signal by which frequency multiplex was carried out, and to change into a frequency modulating signal, It has an optical transmitting means to carry out multiplex [of the output and said second signal of this modulation conversion means], and to change into a lightwave signal. Said modulation conversion means The optical frequency modulation section which considers the amplitude-modulated signal by which frequency multiplex was carried out as a modulation input, and outputs the lightwave signal by which frequency modulation was carried out, The optical frequency local oscillation section which outputs the local oscillation light of this lightwave signal by which frequency modulation was carried out, and the optical frequency which left only the intermediate frequency, The optical multiplexing section which multiplexs said lightwave signal by which frequency modulation was carried out and said local oscillation light, The optical-heterodyne-detection section which considers the lightwave signal it was multiplexed [lightwave signal] by this optical multiplexing section as an input, and outputs the electrical signal of an intermediate frequency equal to the difference of the optical frequency of said lightwave signal by which frequency modulation was carried out and said local oscillation light is included. The optical transmission device characterized by setting up more greatly than the sum of the mesial magnitude of the occupied bandwidth of said lightwave signal by which frequency modulation was carried out, and the occupied bandwidth of said second signal the difference of said local oscillation light and said main optical frequency of a lightwave signal by which frequency modulation was carried out.
[Claim 2] Said amplitude-modulated signal by which frequency multiplex was carried out is an optical transmission device including the video signal of many channels according to claim 1.
[Claim 3] Said optical transmitting means is an optical transmission device containing the electrical signal multiplexing section which multiplexs electrically the electrical signal and said second signal of said intermediate frequency, and the optical transmitting section which outputs the lightwave signal by which intensity modulation was carried out by considering the output signal of this electrical signal multiplexing section as a modulation input according to claim 1 or 2.
[Claim 4] Said optical transmitting means is an optical transmission device containing the two optical transmitting sections which output the lightwave signal by which intensity modulation was carried out by considering the electrical signal and said second signal of said intermediate frequency as a modulation input, respectively, and the optical multiplexing section which multiplexs the output of these two optical transmitting sections according to claim 1 or 2.
[Claim 5] The optical distribution section in which said optical transmitting means distributes the output light of one laser light source and this light source to two, The first external optical modulator which while was distributed, and considers the electrical signal of said intermediate frequency as a modulation input, and carries out intensity modulation of the light, The optical transmission device containing the second external optical modulator which considers said second signal as a modulation input, and carries out intensity modulation of the light of distributed another side, and the optical multiplexing section which multiplexs the output of these two optical transmitting sections according to claim 1 or 2.
[Claim 6] It has the optical receiver which receives the lightwave signal transmitted to the optical transmission line from said optical transmitting means. This optical receiver The light / electric converter which changes a lightwave signal into an electrical signal, and the electrical signal distribution section which allots the electrical

signal which this light / electric converter output for 2 minutes, 5 is [claim 1 which includes the means which carries out opposite phase addition in the electrical signal of another side which adjusted the phase and amplitude of an output of the filter means which takes out the second signal from one side of the distributed electrical signal, and this filter means, and was distributed by said electrical signal distribution section thru/or] the optical transmission device of a publication either.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention is used for transmission of the broadband signal by the lightwave signal. It is related with the technique of transmitting simultaneously the signal by which frequency division multiplex was carried out especially, and other signals with an optical fiber. It is related with the technique of transmitting simultaneously the video signal of cable television (CATV), or a video on demand (VOD) and others, and the signal transmission of a telephone, or data communication and others on the same transmission line, in more detail.
[0002]
[Description of the Prior Art] In image transmission systems, such as CATV, it is required that another video signal should be sent only to the destination which had the demand of transmission like VOD besides the usual video signal. In transmitting various signals, such as a telephone and online communications, besides CATV, in preparing a transmission line for each reason, there is a problem in cost and it has become pressing need to enable it to send many signals in one transmission line.
[0003] When transmitting two or more transmission signals simultaneously, the approach by frequency multiplex has been used conventionally. Such a conventional example is shown in drawing 9 and drawing 10 . Drawing 9 shows the example of a configuration of the optical transmission device which transmits simultaneously the signal transmission (this is called "second signal") of a multi-channel AM video signal, a telephone, or data communication and others, and drawing 10 shows the signal wave form of each part. In drawing 10 , (a) thru/or (d) are the signals of a transmitting side, and the video signal of an intermediate frequency with which the multi-channel AM video signal was carried out for (a), and frequency conversion of the second signal and the (c) was carried out for (b), and (d) show the multiple signal with which it was multiplexed in two signals. Moreover, (e) thru/or (g) are the signals of a receiving side, and the video signal of an intermediate frequency with which (e) was separated from the input signal, the receiving multi-channel AM video signal with which frequency conversion of the (f) was carried out, and (g) show the second signal separated from the input signal.
[0004] In this conventional example, frequency conversion of the multi-channel AM video signal is carried out, and the second signal is transmitted using the vacant frequency band. That is, the multi-channel AM video signal (a) inputted from the first input terminal 101 is inputted into a mixer 103, and the signal from a local oscillator 104 is mixed. By removing the low-pass component of the output of a mixer 103 with the high region filter 105, the video signal (c) of the intermediate frequency by which frequency conversion was carried out is acquired. This high-frequency component of the second signal (b) inputted from the second input terminal 102 on the other hand is removed with the low-pass filter 106. It multiplexs and the output of this low-pass filter 106 and the output of the high region filter 105 are inputted into the optical transmitting section 107. The optical transmitting section 107 is carrying out intensity modulation for example, of the semiconductor laser for transmission, changes the inputted multiplexing signal into a lightwave signal, and transmits to the optical-fiber-transmission way 108. In a receiving side, it changes into an electrical signal with the photodiode in light / electric converter 109, and separates into two signals, and one side is inputted into the high region filter 110, and another side is inputted into the low-pass filter 111. Thereby, the video signal (e) of an intermediate frequency is acquired by the output of the high region filter 110. It mixes with the output of a local oscillator 113 with a mixer 112, frequency conversion of this video signal is carried out, and it returns to the original frequency. Thereby, a multi-channel AM video signal (f) is acquired by the first output terminal 114. On the other hand, the second signal (g) is acquired by the output of the low-pass filter 111, and this is outputted to the second output

terminal 115.
[0005] Although frequency conversion of the multi-channel AM video signal shall be carried out collectively here, frequency conversion can also be carried out for every channel. Moreover, frequency conversion of the second signal may be carried out.
[0006] Here, as shown in drawing 10 , division multiplex [of the frequency band (90MHz thru/or 450MHz)] is carried out to a multi-channel AM video signal, and the occupancy frequency band of the second signal presupposes that they are 0 thru/or 200MHz. In this case, frequency conversion of one signal is carried out, by making it a frequency band not lap mutually, frequency multiplex [of these signals] can be carried out, and they can be transmitted. So, in the example shown in drawing 10 , frequency conversion of the multi-channel AM video signal is carried out to the frequency band (590MHz thru/or 950MHz) using the 500MHz local oscillation signal.
[0007]
[Problem(s) to be Solved by the Invention] If frequency conversion of the video signal is carried out collectively, the cross modulation between each channel will pose a problem. on the other hand, in order to carry out frequency conversion of the video signal of each channel independently, it is the same as the number of channels of a video signal -- it is necessary to prepare the both sides of a transmitting side and a receiving side the frequency conversion section of **, and the more the number of channels increases, the more cost will go up. Moreover, when carrying out frequency conversion of the second signal and the band of this signal is large, the mixer of a broadband will be needed and cost will go up. Image transmission of about 30 channels is desired and much CATV by which current employment is carried out requires image transmission of low cost without the problem of cross modulation.
[0008] Moreover, in a Prior art, a filter is needed for multiplexing of a signal, and separation, and when the group delay frequency characteristics of a filter are inadequate, distortion will arise in a multi-channel AM video signal. Moreover, since the filter with which it is satisfied of properties, such as amplitude deflection and a group delay, over a broadband in one side of the two signals being very a broadband is not obtained, separating into two signals is impossible, without producing distortion.
[0009] Furthermore, in a Prior art, since the multi-channel AM video signal is transmitted with intensity modulation, it is in the middle of transmission, and when branching to multistage, problems, such as waveform distortion, will arise. It is important to increase the number which can branch when lowering the cost per subscriber, and the problem of branching is an important technical problem.
[0010] This invention aims at offering the optical transmission device of the low cost which can solve such a technical problem and can transmit simultaneously the AM signal by which frequency multiplex was carried out, and other signals.
[0011]
[Means for Solving the Problem] In the optical transmission device which the optical transmission device of this invention changes into a lightwave signal the AM signal by which frequency multiplex was carried out, the second different signal from this especially a multi-channel AM video signal, and signals, such as a telephone and online communications, and is multiplexed A modulation conversion means to bundle up the AM signal by which frequency multiplex was carried out, and to change into FM modulating signal, It has an optical transmitting means to carry out multiplex [of the output and the second signal of this modulation conversion means], and to change into a lightwave signal. A modulation conversion means The optical frequency modulation section which considers the AM signal by which frequency multiplex was carried out as a modulation input, and outputs the lightwave signal by which FM modulation was carried out, The optical frequency local oscillation section which outputs the local oscillation light of this lightwave signal by which FM modulation was carried out, and the optical frequency which left only the intermediate frequency, Consider as an input the lightwave signal it was multiplexed [lightwave signal] by the optical multiplexing section which multiplexs the lightwave signal by which FM modulation was carried out, and local oscillation light, and this optical multiplexing section, and the optical-heterodyne-detection section which outputs the electrical signal of an intermediate frequency equal to the difference of the optical frequency of the lightwave signal and local oscillation light by which FM modulation was carried out is included. A difference with the main optical frequency of the lightwave signal by which FM modulation was carried out with local oscillation light is characterized by being set up more greatly than the sum of the mesial magnitude of the occupied bandwidth of a lightwave signal and the occupied bandwidth of the second signal by which FM modulation was carried out.
[0012] The technique which carries out the frequency modulation of the multi-channel AM video signal

collectively is shown in the patent application by the same applicant as this application, and the Heisei 7 patent application No. 073639. This application compounds a package FM video signal by using this technique and making the value of an intermediate frequency into the mesial magnitude of the occupied bandwidth of a package FM video signal, and the value beyond the sum total of the occupied bandwidth of the second signal, without lapping with the second signal. It can multiplex with the second signal by this, without carrying out frequency conversion of each of multi-channel AM video signals, and the second signal can acquire the original multi-channel AM video signal independently by restoring to frequency modulation in a receiving side.
[0013] In this invention, since an AM signal is changed and transmitted to FM modulating signal and the second signal is transmitted by intensity modulation, it is not necessary to use a filter for multiplexing and separation of a signal. Therefore, the problem of the group delay frequency characteristics of a filter can be avoided, and multiplexing of the very large signal of a band is attained.
[0014] As an optical transmitting means, after multiplexing the output and the second signal of a modulation conversion means in the phase of an electrical signal, the configuration of changing into a lightwave signal may be used, and the configuration it multiplexs [configuration] after changing into a lightwave signal may be used. When multiplexing in the phase of an electrical signal, it can have the electrical signal multiplexing section which multiplexs electrically the electrical signal and the second signal of the intermediate frequency which the optical-heterodyne-detection section outputs, and the optical transmitting section which outputs the lightwave signal by which intensity modulation was carried out by considering the output signal of this electrical signal multiplexing section as a modulation input. Moreover, after changing into a lightwave signal, when multiplexing, it can have the two optical transmitting sections which output the lightwave signal by which intensity modulation was carried out by considering the electrical signal and the second signal of an intermediate frequency as a modulation input, respectively, and the optical multiplexing section which multiplexs the output of these two optical transmitting sections. Furthermore, one laser light source and the optical distribution section which distributes the output light of this light source to two, It can also have the first external optical modulator which while was distributed, and considers the electrical signal of an intermediate frequency as a modulation input, and carries out intensity modulation of the light, the second external optical modulator which considers the second signal as a modulation input and carries out intensity modulation of the light of distributed another side, and the optical multiplexing section which multiplexs the output of these two optical transmitting sections.
[0015] It has the optical receiver which receives the lightwave signal transmitted to the optical transmission line from the optical transmitting means. To this optical receiver The light / electric converter which changes a lightwave signal into an electrical signal, and the electrical signal distribution section which allots the electrical signal which this light / electric converter output for 2 minutes, It is good to include the means which carries out opposite phase addition in the electrical signal of another side which adjusted the phase and amplitude of an output of the filter means which takes out the second signal from one side of the distributed electrical signal, and this filter means, and was distributed by the electrical signal distribution section. That is, the broadband signal of another side can be taken out by subtracting one signal from the condition of having been multiplexed in two signals, without producing distortion.
[0016]
[Embodiment of the Invention] Drawing 1 is the block block diagram showing the operation gestalt of this invention. Here, the case where the multi-channel AM video signal by which frequency multiplex was carried out, and the second different signal from this are changed and multiplexed to a lightwave signal is explained. The first input terminal 1 by which, as for the optical transmission device of this operation gestalt, a multi-channel AM video signal is inputted into a transmitting side, The second input terminal 2 into which the second signal other than a video signal is inputted, and package FM modulator 3 which bundles up a multi-channel AM video signal and is changed into FM modulating signal, It has the optical transmitter 4 which carries out multiplex [of the output and the second signal of this package FM modulator 3], and is changed into a lightwave signal, and the output of the optical transmitter 4 is connected to the optical-fiber-transmission way 5. Moreover, a receiving side is equipped with the optical receiver 6 which receives the lightwave signal transmitted to the optical-fiber-transmission way 5 from the optical transmitter 4, FM demodulator 7 which recovers a multi-channel AM video signal from an input signal, the first output terminal 8 to which the multi-channel AM video signal to which it restored is outputted, and the second output terminal 9 to which the second received signal is outputted. As the second signal, two-way communication signals, such as a telephone and data communication, can be considered.

[0017] With this operation gestalt, a package FM modulation is carried out, a multi-channel AM video signal is

also perform and carry out frequency multiplex [of the frequency conversion] from a subscriber side. It is not limited to a two-way communication signal, and, as for the second signal, the class of signal can also use digital baseband signaling and a video signal.

[0027]

[Effect of the Invention] As explained above, the optical transmission device of this invention can transmit simultaneously the AM signal by which frequency multiplex was carried out, and other signals to low cost. In this invention, it is not necessary to use a filter for multiplexing and separation of a signal, the problem of the group delay frequency characteristics of a filter can be avoided, and it becomes possible to carry out multiplex [of the very large signal of a band], and to transmit it. Although this invention is especially used for transmission of a video signal and is effective, there is effectiveness which can use also for transmission of other signals and can increase the efficiency of a transmission line.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention is used for transmission of the broadband signal by the lightwave signal. It is related with the technique of transmitting simultaneously the signal by which frequency division multiplex was carried out especially, and other signals with an optical fiber. It is related with the technique of transmitting simultaneously the video signal of cable television (CATV), or a video on demand (VOD) and others, and the signal transmission of a telephone, or data communication and others on the same transmission line, in more detail.

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PRIOR ART

[Description of the Prior Art] In image transmission systems, such as CATV, it is required that another video signal should be sent only to the destination which had the demand of transmission like VOD besides the usual video signal. In transmitting various signals, such as a telephone and online communications, besides CATV, in preparing a transmission line for each reason, there is a problem in cost and it has become pressing need to enable it to send many signals in one transmission line.

[0003] When transmitting two or more transmission signals simultaneously, the approach by frequency multiplex has been used conventionally. Such a conventional example is shown in drawing 9 and drawing 10 . Drawing 9 shows the example of a configuration of the optical transmission device which transmits simultaneously the signal transmission (this is called "second signal") of a multi-channel AM video signal, a telephone, or data communication and others, and drawing 10 shows the signal wave form of each part. In drawing 10 , (a) thru/or (d) are the signals of a transmitting side, and the video signal of an intermediate frequency with which the multi-channel AM video signal was carried out for (a), and frequency conversion of the second signal and the (c) was carried out for (b), and (d) show the multiple signal with which it was multiplexed in two signals. Moreover, (e) thru/or (g) are the signals of a receiving side, and the video signal of an intermediate frequency with which (e) was separated from the input signal, the receiving multi-channel AM video signal with which frequency conversion of the (f) was carried out, and (g) show the second signal separated from the input signal.

[0004] In this conventional example, frequency conversion of the multi-channel AM video signal is carried out, and the second signal is transmitted using the vacant frequency band. That is, the multi-channel AM video signal (a) inputted from the first input terminal 101 is inputted into a mixer 103, and the signal from a local oscillator 104 is mixed. By removing the low-pass component of the output of a mixer 103 with the high region filter 105, the video signal (c) of the intermediate frequency by which frequency conversion was carried out is acquired. This high-frequency component of the second signal (b) inputted from the second input terminal 102 on the other hand is removed with the low-pass filter 106. It multiplexs and the output of this low-pass filter 106 and the output of the high region filter 105 are inputted into the optical transmitting section 107. The optical transmitting section 107 is carrying out intensity modulation for example, of the semiconductor laser for transmission, changes the inputted multiplexing signal into a lightwave signal, and transmits to the optical-fiber-transmission way 108. In a receiving side, it changes into an electrical signal with the photodiode in light / electric converter 109, and separates into two signals, and one side is inputted into the high region filter 110, and another side is inputted into the low-pass filter 111. Thereby, the video signal (e) of an intermediate frequency is acquired by the output of the high region filter 110. It mixes with the output of a local oscillator 113 with a mixer 112, frequency conversion of this video signal is carried out, and it returns to the original frequency. Thereby, a multi-channel AM video signal (f) is acquired by the first output terminal 114. On the other hand, the second signal (g) is acquired by the output of the low-pass filter 111, and this is outputted to the second output terminal 115.

[0005] Although frequency conversion of the multi-channel AM video signal shall be carried out collectively here, frequency conversion can also be carried out for every channel. Moreover, frequency conversion of the second signal may be carried out.

[0006] Here, as shown in drawing 10 , division multiplex [of the frequency band (90MHz thru/or 450MHz)] is carried out to a multi-channel AM video signal, and the occupancy frequency band of the second signal presupposes that they are 0 thru/or 200MHz. In this case, frequency conversion of one signal is carried out, by making it a frequency band not lap mutually, frequency multiplex [of these signals] can be carried out, and they can be transmitted. So, in the example shown in drawing 10 , frequency conversion of the multi-channel AM

video signal is carried out to the frequency band (590MHz thru/or 950MHz) using the 500MHz local oscillation signal.

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EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, the optical transmission device of this invention can transmit simultaneously the AM signal by which frequency multiplex was carried out, and other signals to low cost. In this invention, it is not necessary to use a filter for multiplexing and separation of a signal, the problem of the group delay frequency characteristics of a filter can be avoided, and it becomes possible to carry out multiplex [of the very large signal of a band], and to transmit it. Although this invention is especially used for transmission of a video signal and is effective, there is effectiveness which can use also for transmission of other signals and can increase the efficiency of a transmission line.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] If frequency conversion of the video signal is carried out collectively, the cross modulation between each channel will pose a problem. on the other hand, in order to carry out frequency conversion of the video signal of each channel independently, it is the same as the number of channels of a video signal — it is necessary to prepare the both sides of a transmitting side and a receiving side the frequency conversion section of **, and the more the number of channels increases, the more cost will go up. Moreover, when carrying out frequency conversion of the second signal and the band of this signal is large, the mixer of a broadband will be needed and cost will go up. Image transmission of about 30 channels is desired and much CATV by which current employment is carried out requires image transmission of low cost without the problem of cross modulation.
[0008] Moreover, in a Prior art, a filter is needed for multiplexing of a signal, and separation, and when the group delay frequency characteristics of a filter are inadequate, distortion will arise in a multi-channel AM video signal. Moreover, since the filter with which it is satisfied of properties, such as amplitude deflection and a group delay, over a broadband in one side of the two signals being very a broadband is not obtained, separating into two signals is impossible, without producing distortion.
[0009] Furthermore, in a Prior art, since the multi-channel AM video signal is transmitted with intensity modulation, it is in the middle of transmission, and when branching to multistage, problems, such as waveform distortion, will arise. It is important to increase the number which can branch when lowering the cost per subscriber, and the problem of branching is an important technical problem.
[0010] This invention aims at offering the optical transmission device of the low cost which can solve such a technical problem and can transmit simultaneously the AM signal by which frequency multiplex was carried out, and other signals.

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MEANS

[Means for Solving the Problem] In the optical transmission device which the optical transmission device of this invention changes into a lightwave signal the AM signal by which frequency multiplex was carried out, the second different signal from this especially a multi-channel AM video signal, and signals, such as a telephone and online communications, and is multiplexed A modulation conversion means to bundle up the AM signal by which frequency multiplex was carried out, and to change into FM modulating signal, It has an optical transmitting means to carry out multiplex [of the output and the second signal of this modulation conversion means], and to change into a lightwave signal. A modulation conversion means The optical frequency modulation section which considers the AM signal by which frequency multiplex was carried out as a modulation input, and outputs the lightwave signal by which FM modulation was carried out, The optical frequency local oscillation section which outputs the local oscillation light of this lightwave signal by which FM modulation was carried out, and the optical frequency which left only the intermediate frequency, Consider as an input the lightwave signal it was multiplexed [lightwave signal] by the optical multiplexing section which multiplexs the lightwave signal by which FM modulation was carried out, and local oscillation light, and this optical multiplexing section, and the optical-heterodyne-detection section which outputs the electrical signal of an intermediate frequency equal to the difference of the optical frequency of the lightwave signal and local oscillation light by which FM modulation was carried out is included. A difference with the main optical frequency of the lightwave signal by which FM modulation was carried out with local oscillation light is characterized by being set up more greatly than the sum of the mesial magnitude of the occupied bandwidth of a lightwave signal and the occupied bandwidth of the second signal by which FM modulation was carried out.

[0012] The technique which carries out the frequency modulation of the multi-channel AM video signal collectively is shown in the patent application by the same applicant as this application, and the Heisei 7 patent application No. 073639. This application compounds a package FM video signal by using this technique and making the value of an intermediate frequency into the mesial magnitude of the occupied bandwidth of a package FM video signal, and the value beyond the sum total of the occupied bandwidth of the second signal, without lapping with the second signal. It can multiplex with the second signal by this, without carrying out frequency conversion of each of multi-channel AM video signals, and the second signal can acquire the original multi-channel AM video signal independently by restoring to frequency modulation in a receiving side.

[0013] In this invention, since an AM signal is changed and transmitted to FM modulating signal and the second signal is transmitted by intensity modulation, it is not necessary to use a filter for multiplexing and separation of a signal. Therefore, the problem of the group delay frequency characteristics of a filter can be avoided, and multiplexing of the very large signal of a band is attained.

[0014] As an optical transmitting means, after multiplexing the output and the second signal of a modulation conversion means in the phase of an electrical signal, the configuration of changing into a lightwave signal may be used, and the configuration it multiplexs [configuration] after changing into a lightwave signal may be used. When multiplexing in the phase of an electrical signal, it can have the electrical signal multiplexing section which multiplexs electrically the electrical signal and the second signal of the intermediate frequency which the optical-heterodyne-detection section outputs, and the optical transmitting section which outputs the lightwave signal by which intensity modulation was carried out by considering the output signal of this electrical signal multiplexing section as a modulation input. Moreover, after changing into a lightwave signal, when multiplexing, it can have the two optical transmitting sections which output the lightwave signal by which intensity modulation was carried out by considering the electrical signal and the second signal of an intermediate frequency as a modulation input, respectively, and the optical multiplexing section which multiplexs the output of these two

optical transmitting sections. Furthermore, one laser light source and the optical distribution section which distributes the output light of this light source to two, It can also have the first external optical modulator which while was distributed, and considers the electrical signal of an intermediate frequency as a modulation input, and carries out intensity modulation of the light, the second external optical modulator which considers the second signal as a modulation input and carries out intensity modulation of the light of distributed another side, and the optical multiplexing section which multiplexs the output of these two optical transmitting sections.
[0015] It has the optical receiver which receives the lightwave signal transmitted to the optical transmission line from the optical transmitting means. To this optical receiver The light / electric converter which changes a lightwave signal into an electrical signal, and the electrical signal distribution section which allots the electrical signal which this light / electric converter output for 2 minutes, It is good to include the means which carries out opposite phase addition in the electrical signal of another side which adjusted the phase and amplitude of an output of the filter means which takes out the second signal from one side of the distributed electrical signal, and this filter means, and was distributed by the electrical signal distribution section. That is, the broadband signal of another side can be taken out by subtracting one signal from the condition of having been multiplexed in two signals, without producing distortion.
[0016]
[Embodiment of the Invention] Drawing 1 is the block block diagram showing the operation gestalt of this invention. Here, the case where the multi-channel AM video signal by which frequency multiplex was carried out, and the second different signal from this are changed and multiplexed to a lightwave signal is explained. The first input terminal 1 by which, as for the optical transmission device of this operation gestalt, a multi-channel AM video signal is inputted into a transmitting side, The second input terminal 2 into which the second signal other than a video signal is inputted, and package FM modulator 3 which bundles up a multi-channel AM video signal and is changed into FM modulating signal, It has the optical transmitter 4 which carries out multiplex [of the output and the second signal of this package FM modulator 3], and is changed into a lightwave signal, and the output of the optical transmitter 4 is connected to the optical-fiber-transmission way 5. Moreover, a receiving side is equipped with the optical receiver 6 which receives the lightwave signal transmitted to the optical-fiber-transmission way 5 from the optical transmitter 4, FM demodulator 7 which recovers a multi-channel AM video signal from an input signal, the first output terminal 8 to which the multi-channel AM video signal to which it restored is outputted, and the second output terminal 9 to which the second received signal is outputted. As the second signal, two-way communication signals, such as a telephone and data communication, can be considered.

[0017] With this operation gestalt, a package FM modulation is carried out, a multi-channel AM video signal is transmitted, and it is characterized by the ability to multiplex by carrying out the intermediate frequency of a package FM modulation beyond the value which added the occupancy frequency band of the second signal to the mesial magnitude of the occupied bandwidth of a package FM video signal, without overlapping the second signal at this time. For this reason, the optical frequency modulation section 31 which considers a multi-channel AM video signal as a modulation input, and outputs the lightwave signal by which FM modulation was carried out to package FM modulator 3, The optical frequency local oscillation section 32 which outputs the local oscillation light of this lightwave signal by which FM modulation was carried out, and the optical frequency which left only the intermediate frequency, The lightwave signal it was multiplexed [lightwave signal] by the optical multiplexing section 33 which multiplexs the lightwave signal by which FM modulation was carried out, and local oscillation light, and this optical multiplexing section 33 is considered as an input, and it has the optical-heterodyne-detection section 34 which outputs the electrical signal of an intermediate frequency equal to the difference of the optical frequency of the lightwave signal and local oscillation light by which FM modulation was carried out. The difference with the main optical frequency of the lightwave signal by which FM modulation was carried out with local oscillation light is set up more greatly than the sum of the mesial magnitude of the occupancy frequency band of a lightwave signal and the occupancy frequency band of the second signal by which FM modulation was carried out.
[0018] Drawing 2 shows the signal wave form of each part of the optical transmission device shown in drawing 1 . In drawing 2 , (a) thru/or (d) are the signals of a transmitting side, and the signal with which the multi-channel AM video signal was carried out for (a), and the package FM modulation of the second signal and the (c) was carried out for (b), and (d) show the modulating-signal component of a sending signal. Moreover, (e) thru/or (g) are the signals of a receiving side, and the package FM modulating signal with which (e) was received, the multi-channel AM video signal which restored to (f), and (g) show the second signal separated from the input signal.

With reference to drawing 2 , actuation of the optical transmission device shown in drawing 1 is explained in more detail.

[0019] Division multiplex [of the frequency band of f1 thru/or f2] is carried out to the multi-channel AM video signal (a) inputted into the first input terminal 1. Moreover, the second signal (b) inputted into the second input terminal 2 makes f3 thru/or f4 the occupancy frequency band. Package FM modulator 3 considers a multi-channel AM video signal as an input, and changes this signal into the package FM video signal (c) which makes f5 thru/or f6 an occupancy frequency band. The optical transmitter 4 multiplexs, after changing this second signal and the output of package FM modulator 3 into the phase or lightwave signal of an electrical signal, and it is transmitted to the optical-fiber-transmission way 5 as an optical multiple signal (d). In the optical receiver 6, the lightwave signal transmitted in the optical-fiber-transmission way 5 is changed into an electrical signal, and it separates into a package FM video signal (e) and the second signal (g) again. By restoring to the separated package FM video signal with FM demodulator 7, the original multi-channel AM video signal (f) is restored. The restored multi-channel AM video signal is outputted to the first output terminal 8, and the second signal is outputted to the second output terminal 9.

[0020] Here, explanation is continued as a value of f1, f2, f3, and f4 as f1=90MHz, f2=450MHz, f3=0MHz, and f4=200MHz.

[0021] The optical frequency modulation section 31 outputs the lightwave signal by which the optical frequency modulation was carried out from a multi-channel AM video signal using the single mode laser for for example, an optical frequency modulation. single mode laser uses also as the optical frequency local oscillation section 32 -- having -- delta-frequency deltafL of the oscillation optical frequency and the oscillation frequency of the optical frequency modulation section 31 In order to prevent a package FM video signal and the second signals overlapping, at the mesial magnitude (deltafFM/2) of occupied-bandwidth deltafFM of a package FM video signal It must be larger than the value (deltafFM/2+deltafsec) which added occupied-bandwidth deltafsec (=f4-f3=0.2GHz) of the second signal. Here, it may be deltafFM=3.2GHz as an example. Therefore, it is deltafFM/2+deltafsec =1.8GHz and may be deltafL =2.1GHz as a larger value than this. delta fFM and delta fL It is set to f5=deltafL-deltafFM / 2= 500MHz, and f6=deltafL+deltafFM / 2= 3.7GHz from a value. These are multiplexed by the optical multiplexing section 33 using an optical coupler. For the lightwave signal it was multiplexed [lightwave signal], it is inputted into the optical-heterodyne-detection section 34, detection on the strength [optical] by the photodiode is performed, and center frequency is deltafL. An equal electrical signal is outputted.

[0022] Drawing 3 thru/or drawing 5 show the separate example of a configuration of the optical transmitter 4. In the example of a configuration shown in drawing 3 , after having the electrical signal multiplexing section 411 and the optical transmitting section 412 and multiplexing a package FM video signal and the second signal in the electrical signal multiplexing section 411, intensity modulation of the semiconductor laser for transmission of the optical transmitting section 412 is carried out by considering this electrical signal as a modulation input. A power multiplexing machine is used as the electrical signal multiplexing section 411. In the example of a configuration shown in drawing 4 , it has the two optical transmitting sections 421 and 422 and optical multiplexing sections 423, a package FM video signal and the second signal are respectively inputted into the optical transmitting sections 421 and 422 separate as a modulation input, intensity modulation of the semiconductor laser for transmission is carried out, and the acquired lightwave signal is multiplexed with the optical coupler of the optical multiplexing section 423. In the example of a configuration shown in drawing 5 , it has a laser light source 431, the external optical modulators 433 and 434 of the 432 or 2 optical distribution sections, the optical delay line 435, and the optical multiplexing section 436, intensity modulation of the output light from a laser light source 431 is carried out with the external optical modulator 433 which considers a package FM video signal for one side as a modulation input at the optical coupler of the optical distribution section 432 by dividing into two, and intensity modulation of another side is carried out with the external optical modulator 434 which considers the second signal as a modulation input. The output light of the external optical modulators 433 and 434 multiplexs in the optical multiplexing section 436, after giving the differential delay more than coherent length with the optical delay line 435. The optical delay line 435 is used for preventing the light divided into two interfering again.

[0023] Drawing 6 shows the example of a configuration of the optical receiver 6. This optical receiver 6 is equipped with light / electric converter 61, the electrical signal distribution section 62, the low-pass filter 63, the electrical signal distribution section 64, a phase and an amplitude controller 65, and the electrical signal multiplexing section 66, and equips a phase and the amplitude controller 65 with a phase inverter 651, a phase adjuster 652, the electric amplifier 653, and variable attenuator 654. Light / electric converter 61 changes into

an electrical signal the lightwave signal transmitted in the optical-fiber-transmission way 5, and the electrical signal distribution section 62 distributes this electrical signal to two. While was distributed, and the low-pass filter 63 inputs another side into a phase and the amplitude controller 65 while ejection and the electrical signal distribution section 64 output one of these for the second signal from a signal. In a phase and the amplitude controller 65, the phase of the second signal is reversed with a phase inverter 651, in case it multiplexs with another [which was distributed in the electrical signal distribution section 62 by the phase adjuster 652] signal, a phase is adjusted so that it may become the form of subtraction exactly, and the electric amplifier 653 and variable attenuator 654 adjust amplitude level. The electrical signal multiplexing section 66 multiplexs with the signal to which the output of a phase and the amplitude controller 65 was distributed by the electrical signal distribution section 62, and it takes out a package FM video signal, without using a filter.

[0024] Drawing 7 shows the example of a configuration of FM demodulator 7. This FM demodulator 7 is the delay detector circuit known well, and is equipped with a limiter 71, the delay line 72, a flip-flop 73, and the low-pass filter 74. While shaping in waveform the package FM video signal to which it should restore by the limiter 71 and supplying the set input of a flip-flop 73, the reset input of a flip-flop 73 is supplied via the delay line 72. A multi-channel AM video signal gets over with outputting the output of a flip-flop 73 through the low-pass filter 74.

[Translation done.]

EXAMPLE

[Example] Drawing 8 shows the example in the case of transmitting signals other than a video signal bidirectionally. A center side is equipped with the first input terminal 1, second input terminal 2, package FM modulator 3, and optical transmitter 4, and the communication system sending signal as the second signal is inputted into a multi-channel AM video signal and the second input terminal at the first input terminal 1. A center side is further equipped with the optical coupler 13 which branches the communication system input signal from a subscriber side from the optical-fiber-transmission way 5, and the optical receiver 14 which receives the branched lightwave signal, and it has the output terminal 15 which outputs a communication system input signal. Moreover, in addition to the optical receiver 6, FM demodulator 7, the first, and the second output terminal 8 and 9, a subscriber side is equipped with the input terminal 10 into which a communication system sending signal is inputted, the optical transmitter 11 which changes and outputs the signal to a lightwave signal, and the optical coupler 12 which combines a lightwave signal with the optical-fiber-transmission way 5.
[0026] The signal sent to a subscriber side from a center side, and since it is incoherent, multiplexing of the signal sent to a center side from a subscriber side is possible as it is using the optical couplers 12 and 13. An optical turnout is prepared in the optical-fiber-transmission way 5, and it can communicate between one center side apparatus and two or more subscriber side equipments. Multiplexing and branching of the lightwave signal in this case may use a wavelength multiplexing coupler as usual. Moreover, the signal sent to a center side may also perform and carry out frequency multiplex [of the frequency conversion] from a subscriber side. It is not limited to a two-way communication signal, and, as for the second signal, the class of signal can also use digital baseband signaling and a video signal.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block block diagram showing the operation gestalt of this invention.
[Drawing 2] Drawing showing the signal wave form of each part.
[Drawing 3] The block diagram showing the example of a configuration of an optical transmitter.
[Drawing 4] The block diagram showing another example of a configuration of an optical transmitter.
[Drawing 5] The block diagram showing still more nearly another example of a configuration of an optical transmitter.
[Drawing 6] The block diagram showing the example of a configuration of an optical receiver.
[Drawing 7] The block diagram showing the example of a configuration of an FM demodulator.
[Drawing 8] The block block diagram showing the example in the case of transmitting signals other than a video signal bidirectionally.
[Drawing 9] The block block diagram showing the optical transmission device of the conventional example.
[Drawing 10] Drawing showing the signal wave form of each part.
[Description of Notations]
1 First Input Terminal
2 Second Input Terminal
3 Package FM Modulator
4 11 Optical transmitter
5 Optical-Fiber-Transmission Way
6 14 Optical receiver
7 FM Demodulator
8 First Output Terminal
9 Second Output Terminal
10 Input Terminal
12 13 Optical coupler
15 Output Terminal
31 Optical Frequency Modulation Section
32 Optical Frequency Local Oscillation Section
33 Optical Multiplexing Section
34 Optical-Heterodyne-Detection Section
411 Electrical Signal Multiplexing Section
412, 421, 422 Optical transmitting section
423 436 Optical multiplexing section
431 Laser Light Source
432 Optical Distribution Section
433 434 External optical modulator
435 Optical Delay Line
61 Light / Electric Converter
62 Electrical Signal Distribution Section
63 74 Low-pass filter
64 Electrical Signal Distribution Section
65 Phase and Amplitude Controller

66 Electrical Signal Multiplexing Section
651 Phase Inverter
652 Phase Adjuster
653 Electric Amplifier
654 Variable Attenuator
71 Limiter
72 Delay Line
73 Flip-flop

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(73)特許権者　000004226
日本電信電話株式会社
東京都千代田区大手町二丁目３番１号
(72)発明者　池田　智
東京都新宿区西新宿三丁目19番２号　日本電信電話株式会社内
(72)発明者　菊島　浩二
東京都新宿区西新宿三丁目19番２号　日本電信電話株式会社内
(72)発明者　雲崎　清美
東京都新宿区西新宿三丁目19番２号　日本電信電話株式会社内
(74)代理人　100078237
弁理士　井出　直孝　(外１名)

審査官　丸山　高政

最終頁に続く

(54)【発明の名称】　光伝送装置

(57)【特許請求の範囲】
【請求項１】　周波数多重された振幅変調信号とこれとは異なる第二の信号とを光信号に変換して多重伝送する光伝送装置において、
前記周波数多重された振幅変調信号を一括して周波数変調信号に変換する変調変換手段と、
この変調変換手段の出力と前記第二の信号とを多重して光信号に変換する光送信手段とを備え、
前記変調変換手段は、周波数多重された振幅変調信号を変調入力とし周波数変調された光信号を出力する光周波数変調部と、この周波数変調された光信号と中間周波数だけ離れた光周波数の局部発振光を出力する光周波数局部発振部と、前記周波数変調された光信号と前記局部発振光とを合波する光合波部と、この光合波部により合波された光信号を入力とし前記周波数変調された光信号と

前記局部発振光との光周波数の差に等しい中間周波数の電気信号を出力する光ヘテロダイン検波部とを含み、
前記局部発振光と前記周波数変調された光信号の中心光周波数との差が、前記周波数変調された光信号の占有周波数帯幅の半値と前記第二の信号の占有周波数帯幅との和より大きく設定されたことを特徴とする光伝送装置。
【請求項２】　前記周波数多重された振幅変調信号は多チャンネルの映像信号を含む請求項１記載の光伝送装置。
【請求項３】　前記光送信手段は、前記中間周波数の電気信号と前記第二の信号とを電気的に合波する電気信号合波部と、この電気信号合波部の出力信号を変調入力として強度変調された光信号を出力する光送信部とを含む請求項１または２記載の光伝送装置。
【請求項４】　前記光送信手段は、前記中間周波数の電

気信号と前記第二の信号とをそれぞれ変調入力として強度変調された光信号を出力する二つの光送信部と、この二つの光送信部の出力を合波する光合波部とを含む請求項１または２記載の光伝送装置。

【請求項５】　前記光送信手段は、一つのレーザ光源と、この光源の出力光を二つに分配する光分配部と、分配された一方の光を前記中間周波数の電気信号を変調入力として強度変調する第一の外部光変調器と、分配された他方の光を前記第二の信号を変調入力として強度変調する第二の外部光変調器と、この二つの光送信部の出力を合波する光合波部とを含む請求項１または２記載の光伝送装置。

【請求項６】　前記光送信手段から光伝送路に送信された光信号を受信する光受信機を備え、

この光受信機は、光信号を電気信号に変換する光／電気変換部と、この光／電気変換部の出力する電気信号を二分配する電気信号分配部と、分配された電気信号の一方から第二の信号を取り出すフィルタ手段と、このフィルタ手段の出力の位相および振幅を調整して前記電気信号分配部により分配された他方の電気信号に逆相加算する手段とを含む請求項１ないし５のいずれか記載の光伝送装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は光信号による広帯域信号の伝送に利用する。特に、周波数分割多重された信号と他の信号とを光ファイバで同時に伝送する技術に関する。さらに詳しくは、ケーブルテレビジョン（ＣＡＴＶ）あるいはビデオオンデマンド（ＶＯＤ）その他の映像信号と、電話あるいはデータ通信その他の通信信号とを同一伝送路上で同時に伝送する技術に関する。

【０００２】

【従来の技術】ＣＡＴＶなどの映像伝送システムでは、通常の映像信号のほか、ＶＯＤのように伝送の要求があった宛先にのみ別の映像信号を送ることが要求されている。ＣＡＴＶの他にも、電話やコンピュータ通信といった種々の信号を伝送する場合には、それぞれのために伝送路を用意するのではコスト的に問題があり、ひとつの伝送路で多くの信号を送れるようにすることが急務となっている。

【０００３】二つ以上の伝送信号を同時に伝送する場合、従来は周波数多重による方法が用いられてきた。そのような従来例を図９および図１０に示す。図９は多チャンネルＡＭ映像信号と電話あるいはデータ通信その他の通信信号（これを「第二の信号」という）とを同時に伝送する光伝送装置の構成例を示し、図１０は各部の信号波形を示す。図１０において、（ａ）ないし（ｄ）は送信側の信号であり、（ａ）は多チャンネルＡＭ映像信号、（ｂ）は第二の信号、（ｃ）は周波数変換された中間周波数の映像信号、（ｄ）は二つの信号が合波された

多重信号を示す。また、（ｅ）ないし（ｇ）は受信側の信号であり、（ｅ）は受信信号から分離された中間周波数の映像信号、（ｆ）は周波数変換された受信多チャンネルＡＭ映像信号、（ｇ）は受信信号から分離された第二の信号を示す。

【０００４】この従来例では、多チャンネルＡＭ映像信号を周波数変換し、空いた周波数帯域を使って第二の信号を伝送する。すなわち、第一の入力端子１０１から入力された多チャンネルＡＭ映像信号（ａ）をミキサ１０３に入力し、局部発振器１０４からの信号と混合する。ミキサ１０３の出力の低域成分を高域濾波器１０５により除去することで、周波数変換された中間周波数の映像信号（ｃ）が得られる。この一方、第二の入力端子１０２から入力された第二の信号（ｂ）の高域成分を低域濾波器１０６で取り除いておく。この低域濾波器１０６の出力と高域濾波器１０５の出力とを合波し、光送信部１０７に入力する。光送信部１０７は、例えば送信用半導体レーザを強度変調することで、入力された合波信号を光信号に変換し、光ファイバ伝送路１０８に送信する。受信側では、光／電気変換部１０９内のフォトダイオードにより電気信号に変換し、二つの信号に分離して、一方を高域濾波器１１０、他方を低域濾波器１１１に入力する。これにより、高域濾波器１１０の出力には中間周波数の映像信号（ｅ）が得られる。この映像信号をミキサ１１２により局部発振器１１３の出力と混合して周波数変換し、元の周波数に戻す。これにより、第一の出力端子１１４に多チャンネルＡＭ映像信号（ｆ）が得られる。一方、低域濾波器１１１の出力には第二の信号（ｇ）が得られ、これが第二の出力端子１１５に出力される。

【０００５】ここでは多チャンネルＡＭ映像信号を一括して周波数変換するものとしたが、各チャンネルごとに周波数変換することもできる。また、第二の信号を周波数変換してもよい。

【０００６】ここで、図１０に示すように、多チャンネルＡＭ映像信号には９０ＭＨｚないし４５０ＭＨｚの周波数帯域が分割多重され、第二の信号の占有周波数帯域は０ないし２００ＭＨｚであるとする。この場合、一方の信号を周波数変換し、互いに周波数帯が重ならないようにすることで、これらの信号を周波数多重して伝送することができる。そこで図１０に示す例では、５００ＭＨｚの局部発振信号を用い、多チャンネルＡＭ映像信号を５９０ＭＨｚないし９５０ＭＨｚの周波数帯域に周波数変換している。

【０００７】

【発明が解決しようとする課題】映像信号を一括して周波数変換すると、各チャンネル間の混変調が問題となる。一方、各チャンネルの映像信号を別々に周波数変換するには、映像信号のチャンネル数と同じだけの周波数変換部を送信側および受信側の双方に設ける必要があ

り、チャンネル数が増えれば増えるほどコストが上昇してしまう。また、第二の信号を周波数変換する場合には、この信号の帯域が広い場合、広帯域のミキサが必要となり、コストが上昇してしまう。現在運用されている多くのＣＡＴＶでは３０チャンネル程度の映像伝送が望まれており、混変調の問題のない低コストの映像伝送が要求されている。

【０００８】また、従来の技術では、信号の合波および分離のために濾波器が必要となり、濾波器の群遅延特性が不十分な場合には多チャンネルＡＭ映像信号に歪みが生じてしまう。また、二つの信号のうちの一方が非常に広帯域であると、広帯域にわたって振幅偏差や群遅延などの特性を満足する濾波器が得られないため、歪を生じさせることなく二つの信号に分離することは不可能である。

【０００９】さらに、従来の技術では多チャンネルＡＭ映像信号を強度変調のまま送信しているため、伝送途中で多段に分岐する場合には波形歪などの問題が生じてしまう。一加入者あたりのコストを下げる上で分岐可能な数を増やすことは重要であり、分岐の問題は重要な課題である。

【００１０】本発明は、このような課題を解決し、周波数多重されたＡＭ変調信号と他の信号とを同時に伝送することのできる低コストの光伝送装置を提供することを目的とする。

【００１１】

【課題を解決するための手段】本発明の光伝送装置は、周波数多重されたＡＭ変調信号とこれとは異なる第二の信号、特に多チャンネルＡＭ映像信号と電話やコンピュータ通信などの信号を光信号に変換して多重伝送する光伝送装置において、周波数多重されたＡＭ変調信号を一括してＦＭ変調信号に変換する変調変換手段と、この変調変換手段の出力と第二の信号とを多重して光信号に変換する光送信手段とを備え、変調変換手段は、周波数多重されたＡＭ変調信号を変調入力としＦＭ変調された光信号を出力する光周波数変調部と、このＦＭ変調された光信号と中間周波数だけ離れた光周波数の局部発振光を出力する光周波数局部発振部と、ＦＭ変調された光信号と局部発振光とを合波する光合波部と、この光合波部により合波された光信号を入力としＦＭ変調された光信号と局部発振光との光周波数の差に等しい中間周波数の電気信号を出力する光ヘテロダイン検波部とを含み、局部発振光とＦＭ変調された光信号の中心光周波数との差が、ＦＭ変調された光信号の占有周波数帯幅の半値と第二の信号の占有周波数帯幅との和より大きく設定されたことを特徴とする。

【００１２】多チャンネルＡＭ映像信号を一括して周波数変調する技術については、本願と同一出願人による特許出願、平成７年特許願第０７３６３９号に示されている。本願は、この技術を利用し、中間局波数の値を一括ＦＭ映像信号の占有周波数帯幅の半値と第二の信号の占有周波数帯幅の合計以上の値とすることによって、一括ＦＭ映像信号を第二の信号と重なることなく合成するものである。これにより、多チャンネルＡＭ映像信号のひとつひとつを周波数変換することなく第二の信号と合波でき、受信側では、周波数変調を復調することにより第二の信号とは別に元の多チャンネルＡＭ映像信号を得ることができる。

【００１３】本発明では、ＡＭ変調信号をＦＭ変調信号に変換して伝送し、第二の信号を強度変調により伝送するので、信号の合波および分離に濾波器を用いる必要がない。したがって、濾波器の群遅延特性の問題を回避でき、帯域の非常に広い信号の合波が可能となる。

【００１４】光送信手段としては、変調変換手段の出力と第二の信号とを電気信号の段階で合波してから光信号に変換する構成でもよく、光信号に変換してから合波する構成でもよい。電気信号の段階で合波する場合には、光ヘテロダイン検波部の出力する中間周波数の電気信号と第二の信号とを電気的に合波する電気信号合波部と、この電気信号合波部の出力信号を変調入力として強度変調された光信号を出力する光送信部とを備えることができる。また、光信号に変換してから合波する場合には、中間周波数の電気信号と第二の信号とをそれぞれ変調入力として強度変調された光信号を出力する二つの光送信部と、この二つの光送信部の出力を合波する光合波部とを備えることができる。さらに、一つのレーザ光源と、この光源の出力光を二つに分配する光分配部と、分配された一方の光を中間周波数の電気信号を変調入力として強度変調する第一の外部光変調器と、分配された他方の光を第二の信号を変調入力として強度変調する第二の外部光変調器と、この二つの光送信部の出力を合波する光合波部とを備えることもできる。

【００１５】光送信手段から光伝送路に送信された光信号を受信する光受信機を備え、この光受信機には、光信号を電気信号に変換する光／電気変換部と、この光／電気変換部の出力する電気信号を二分配する電気信号分配部と、分配された電気信号の一方から第二の信号を取り出すフィルタ手段と、このフィルタ手段の出力の位相および振幅を調整して電気信号分配部により分配された他方の電気信号に逆相加算する手段とを含むことがよい。すなわち、二つの信号が合波された状態から一方の信号を引き算することによって、歪を生じさせることなく他方の広帯域信号を取り出すことができる。

【００１６】

【発明の実施の形態】図１は本発明の実施形態を示すブロック構成図である。ここでは、周波数多重された多チャンネルＡＭ映像信号と、これとは異なる第二の信号とを光信号に変換して多重伝送する場合について説明する。この実施形態の光伝送装置は、送信側に、多チャンネルＡＭ映像信号が入力される第一の入力端子１と、映

像信号とは別の第二の信号が入力される第二の入力端子２と、多チャンネルＡＭ映像信号を一括してＦＭ変調信号に変換する一括ＦＭ変調器３と、この一括ＦＭ変調器３の出力と第二の信号とを多重して光信号に変換する光送信機４とを備え、光送信機４の出力が光ファイバ伝送路５に接続される。また、受信側には、光送信機４から光ファイバ伝送路５に送信された光信号を受信する光受信機６と、受信信号から多チャンネルＡＭ映像信号を復調するＦＭ復調器７と、復調された多チャンネルＡＭ映像信号が出力される第一の出力端子８と、受信された第二の信号が出力される第二の出力端子９とを備える。第二の信号としては、電話、データ通信などの双方向通信信号が考えられる。

【００１７】本実施形態では、多チャンネルＡＭ映像信号を一括ＦＭ変調して伝送し、このとき、一括ＦＭ変調の中間周波数を一括ＦＭ映像信号の占有周波数帯幅の半値に第二の信号の占有周波数帯を加えた値以上にすることで、第二の信号と重なりあうことなく合波することができることを特徴とする。このため一括ＦＭ変調器３には、多チャンネルＡＭ映像信号を変調入力としＦＭ変調された光信号を出力する光周波数変調部３１と、このＦＭ変調された光信号と中間周波数だけ離れた光周波数の局部発振光を出力する光周波数局部発振部３２と、ＦＭ変調された光信号と局部発振光とを合波する光合波部３３と、この光合波器３３により合波された光信号を入力としＦＭ変調された光信号と局部発振光との光周波数の差に等しい中間周波数の電気信号を出力する光ヘテロダイン検波器３４とを備える。局部発振光とＦＭ変調された光信号の中心光周波数との差は、ＦＭ変調された光信号の占有周波数帯域の半値と第二の信号の占有周波数帯域との和より大きく設定される。

【００１８】図２は図１に示した光伝送装置の各部の信号波形を示す。図２において、（ａ）ないし（ｄ）は送信側の信号であり、（ａ）は多チャンネルＡＭ映像信号、（ｂ）は第二の信号、（ｃ）は一括ＦＭ変調された信号、（ｄ）は送信信号の変調信号成分を示す。また、（ｅ）ないし（ｇ）は受信側の信号であり、（ｅ）は受信された一括ＦＭ変調信号、（ｆ）は復調された多チャンネルＡＭ映像信号、（ｇ）は受信信号から分離された第二の信号を示す。図２を参照して、図１に示した光伝送装置の動作をさらに詳しく説明する。

【００１９】第一の入力端子１に入力される多チャンネルＡＭ映像信号（ａ）には、ｆ１ないしｆ２の周波数帯域が分割多重されている。また、第二の入力端子２に入力される第二の信号（ｂ）は、ｆ３ないしｆ４を占有周波数帯域としている。一括ＦＭ変調器３は、多チャンネルＡＭ映像信号を入力とし、この信号をｆ５ないしｆ６を占有周波数帯域とする一括ＦＭ映像信号（ｃ）に変換する。光送信機４は、この第二の信号と一括ＦＭ変調器３の出力とを電気信号の段階あるいは光信号に変換してから合波し、光多重信号（ｄ）として光ファイバ伝送路５へ送信する。光受信機６では、光ファイバ伝送路５を伝送されてきた光信号を電気信号に変換し、再び一括ＦＭ映像信号（ｅ）と第二の信号（ｇ）とに分離する。分離された一括ＦＭ映像信号をＦＭ復調器７により復調することで、元の多チャンネルＡＭ映像信号（ｆ）が復元される。復元された多チャンネルＡＭ映像信号は第一の出力端子８に出力され、第二の信号は第二の出力端子９に出力される。

【００２０】ここで、ｆ１、ｆ２、ｆ３、ｆ４の値として、ｆ１＝９０ＭＨｚ、ｆ２＝４５０ＭＨｚ、ｆ３＝０ＭＨｚ、ｆ４＝２００ＭＨｚとして説明を続ける。

【００２１】光周波数変調部３１は、例えば光周波数変調用の単一モードレーザを用い、多チャンネルＡＭ映像信号から、光周波数変調された光信号を出力する。光周波数局部発振部３２としても単一モードレーザが用いられ、その発振光周波数と光周波数変調部３１の発振周波数との周波数差Δｆｓは、一括ＦＭ映像信号と第二の信号とが重なりあうことを防ぐため、一括ＦＭ映像信号の占有周波数帯幅Δｆｆｍの半値（Δｆｆｍ／２）に、第二の信号の占有周波数帯幅Δｆｓｃ（＝ｆ４－ｆ３＝０．２ＧＨｚ）を加えた値（Δｆｆｍ／２＋Δｆｓｃ）より大きくなければならない。ここでは一例として、Δｆｆｍ＝３．２ＧＨｚとする。したがってΔｆｆｍ／２＋Δｆｓｃ＝１．８ＧＨｚであり、これより大きい値として、Δｆｓ＝２．１ＧＨｚとする。Δｆｆｍ、Δｆｓの値から、ｆ５＝Δｆｓ－Δｆｆｍ／２＝５００ＭＨｚ、ｆ６＝Δｆｓ＋Δｆｆｍ／２＝３．７ＧＨｚとなる。これらを例えば光カプラを用いた光合波部３３により合波する。合波された光信号は光ヘテロダイン検波部３４に入力され、フォトダイオードによる光強度検波が行われ、中心周波数がΔｆｓと等しい電気信号が出力される。

【００２２】図３ないし図５は光送信機４の別々の構成例を示す。図３に示す構成例では、電気信号合波部４１１と光送信部４１２とを備え、一括ＦＭ映像信号と第二の信号とを電気信号合波部４１１で合波した後、この電気信号を変調入力として、光送信部４１２の送信用半導体レーザを強度変調する。電気信号合波部４１１としては、電力合波器が用いられる。図４に示す構成例では、二つの光送信部４２１、４２２と光合波部４２３とを備え、一括ＦＭ映像信号と第二の信号とを各々変調入力として別々の光送信部４２１、４２２に入力して送信用半導体レーザを強度変調し、得られた光信号を光合波部４２３の光カプラで合波する。図５に示す構成例では、レーザ光源４３１、光分配部４３２、二つの外部光変調器４３３、４３４、光遅延線４３５および光合波部４３６を備え、レーザ光源４３１からの出力光を光分配部４３２の光カプラで二つに分け、片方を一括ＦＭ映像信号を変調入力とする外部光変調器４３３により強度変調し、他方を第二の信号を変調入力とする外部光変調器４３４

により強度変調する。外部光変調器４３３、４３４の出力光は、光遅延線４３５によりコヒーレント長以上の遅延差を与えた後に、光合波器４３６で合波する。光遅延線４３５を用いるのは、二つに分けた光が再び干渉することを防ぐためである。

【００２３】図８は光受信機６の構成例を示す。この光受信機６は光／電気変換部６１、電気信号分配部６２、低域濾波器６３、電気信号分配部６４、位相・振幅調整部６５および電気信号合波部６６を備え、位相・振幅調整部６５には、位相反転器６５１、位相調整器６５２、電気増幅器６５３および可変減衰器６５４を備える。光／電気変換部６１は光ファイバ伝送路５を伝送されてきた光信号を電気信号に変換し、電気信号分配部６２はこの電気信号を二つに分配する。低域濾波器６３は分配された一方の信号から第二の信号を取り出し、電気信号分配部６４はその一方を出力するとともに、他方を位相・振幅調整部６５に入力する。位相・振幅調整部６５では、位相反転器６５１により第二の信号の位相を反転させ、位相調整器６５２により電気信号分配部６２で分配されたもう一方の信号と合波する際にちょうど引き算のだとなるように位相を調整し、電気増幅器６５３および可変減衰器６５４により振幅レベルを調整する。電気信号合波部６６は、位相・振幅調整部６５の出力を電気信号分配部６２により分配された信号と合波し、濾波器を用いることなく一括ＦＭ映像信号を取り出す。

【００２４】図７はＦＭ復調器７の構成例を示す。このＦＭ復調器７は良く知られた遅延検波回路であり、リミッタ７１、遅延線７２、フリップフロップ７３および低域濾波器７４を備える。復調すべき一括ＦＭ映像信号をリミッタ７１により波形整形し、フリップフロップ７３のセット入力に供給するとともに、遅延線７２を経由してフリップフロップ７３のリセット入力に供給する。フリップフロップ７３の出力を低域濾波器７４を通して出力することで、多チャンネルＡＭ映像信号が復調される。

【００２５】

【実施例】図８は映像信号以外の信号を双方向に伝送する場合の実施例です。センタ側には第一の入力端子１、第二の入力端子２、一括ＦＭ変調器３および光送信機４を備え、第一の入力端子１には多チャンネルＡＭ映像信号、第二の入力端子には第二の信号としての通信系送信信号が入力される。センタ側にはさらに、加入者側からの通信系受信信号を光ファイバ伝送路５から分岐する光カプラ１３と、分岐された光信号を受信する光受信機１４とを備え、通信系受信信号を出力する出力端子１５を備える。また、加入者側には、光受信機６、ＦＭ復調器７、第一および第二の出力端子８、９に加え、通信系送信信号が入力される入力端子１０、その信号を光信号に変換して出力する光送信機１１、および光信号を光ファイバ伝送路５に結合する光カプラ１２を備える。

【００２６】加入者側からセンタ側へ送られる信号は、センタ側から加入者側へ送られる信号とインコヒーレントであるため、光カプラ１２、１３を用いてそのまま合波ができる。光ファイバ伝送路５には光分岐器が設けられ、ひとつのセンタ側装置と複数の加入者側装置との間で通信が可能である。この場合の光信号の合波および分岐は、従来通り波長多重カプラを用いてもよい。また、加入者側からセンタ側へ送られる信号も周波数変換を行って周波数多重してもよい。第二の信号は双方向通信信号に限定されるものではなく、信号の種類もディジタルベースバンド信号や映像信号を利用できる。

【００２７】

【発明の効果】以上説明したように、本発明の光伝送装置は、周波数多重されたＡＭ変調信号と他の信号とを同時に低コストに伝送できる。本発明では、信号の合波および分離に濾波器を用いる必要がなく、濾波器の群遅延特性の問題を回避でき、帯域の非常に広い信号を多重して伝送することが可能となる。本発明は、映像信号の伝送に用いて特に効果があるが、他の信号の伝送にも利用して伝送路を効率化することができる効果がある。

【図面の簡単な説明】

【図１】本発明の実施形態を示すブロック構成図。

【図２】各部の信号波形を示す図。

【図３】光送信機の構成例を示すブロック図。

【図４】光送信機の別の構成例を示すブロック図。

【図５】光送信機のさらに別の構成例を示すブロック図。

【図６】光受信機の構成例を示すブロック図。

【図７】ＦＭ復調器の構成例を示すブロック図。

【図８】映像信号以外の信号を双方向に伝送する場合の実施例を示すブロック構成図。

【図９】従来例の光伝送装置を示すブロック構成図。

【図１０】各部の信号波形を示す図。

【符号の説明】

１　第一の入力端子
２　第二の入力端子
３　一括ＦＭ変調器
４、１１　光送信機
５　光ファイバ伝送路
６、１４　光受信機
７　ＦＭ復調器
８　第一の出力端子
９　第二の出力端子
１０　入力端子
１２、１３　光カプラ
１５　出力端子
３１　光周波数変調部
３２　光周波数局部発振部
３３　光合波部
３４　光ヘテロダイン検波部

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４１１　電気信号合波部
４１２、４２１、４２２　光送信部
４２３、４３６　光合波部
４３１　レーザ光源
４３２　光分配部
４３３、４３４　外部光変調器
４３５　光遅延線
６１　光／電気変換部
６２　電気信号分配部
６３、７４　低域濾波器

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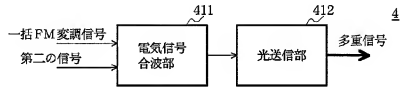
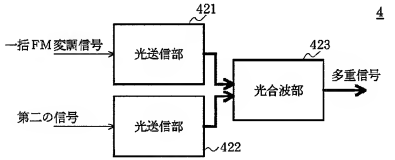
＊６４　電気信号分配部
６５　位相・振幅調整部
６６　電気信号合波部
６５１　位相反転器
６５２　位相調整器
６５３　電気増幅器
６５４　可変減衰器
７１　リミッタ
７２　遅延線
＊10　７３　フリップフロップ

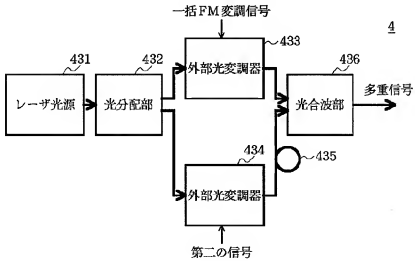
【図３】



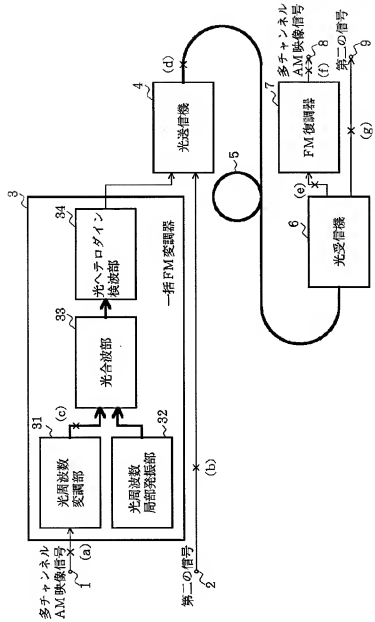
【図４】



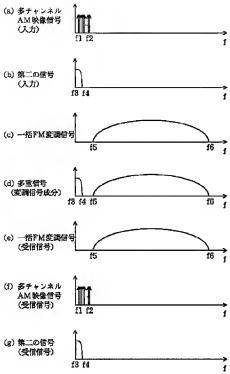
【図５】



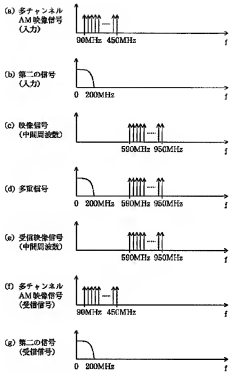
【図１】


多チャンネル
AM映像信号
(a)
1
光周波数
変調部
31
(c)
光周波数
局部発振部
32
光合波部
33
光ヘテロダイン
検波部
34
一括FM変調器
3
(b)
第二の信号
2
光送信機
4
(d)
5
光受信機
6
(e)
FM復調器
7
多チャンネル
AM映像信号
(f)
8
第二の信号
(g)
9

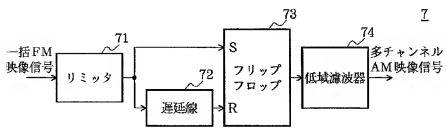
【図２】


(a) 多チャンネル AM映像信号 (入力)
f1 f2
f
(b) 第二の信号 (入力)
f3 f4
(c) 一括FM変調信号
f5 f6
(d) 多重信号 (変調信号成分)
f3 f4 f5 f0
(e) 一括FM変調信号 (受信信号)
(f) 多チャンネル AM映像信号 (受信信号)
(g) 第二の信号 (受信信号)

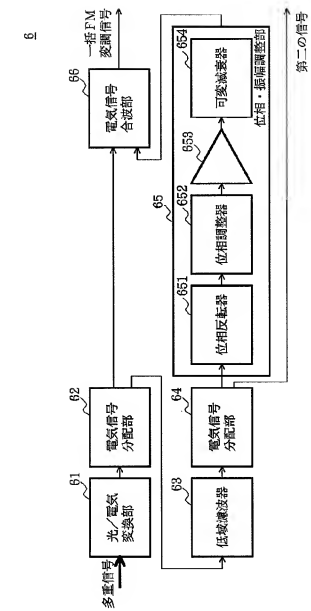
【図１０】


(a) 多チャンネル AM映像信号 (入力)
900MHz 450MHz
f
(b) 第二の信号 (入力)
0 200MHz
(c) 映像信号 (中間周波数)
500MHz 950MHz
(d) 多重信号
0 200MHz 500MHz 950MHz
(e) 受信映像信号 (中間周波数)
(f) 多チャンネル AM映像信号 (受信信号)
(g) 第二の信号 (受信信号)

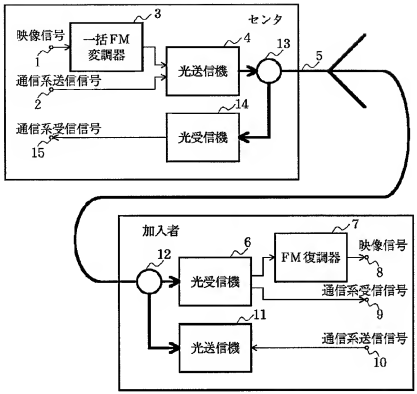
【図７】


7
71
72
73
74
一括FM 映像信号
リミッタ
遅延線
S
フリップ フロップ
R
低域濾波器
多チャンネル AM映像信号

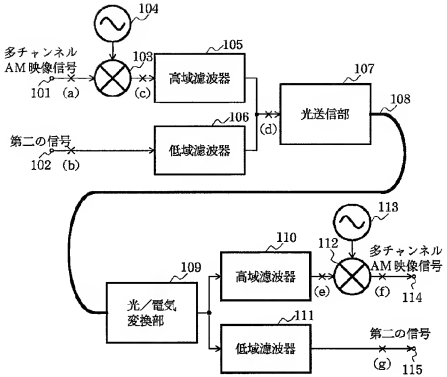
【図６】


6
多重信号
光／電気変換部
61
電気信号分配部
62
低域濾波器
63
電気信号分配部
64
65
位相反転器
651
位相調整器
652
653
可変減衰器
654
位相・振幅調整部
電気信号合波部
66
一括FM変調信号
第二の信号

【図８】


センタ
3
映像信号
一括FM
変調器
1
4
光送信機
13
5
通信系送信信号
2
14
光受信機
通信系受信信号
15
加入者
7
6
12
FM復調器
映像信号
8
光受信機
通信系受信信号
9
11
光送信機
通信系送信信号
10

【図９】



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(72)発明者　玉木　規夫
東京都新宿区西新宿三丁目19番２号　日本電信電話株式会社内
(72)発明者　柴田　宜
東京都新宿区西新宿三丁目19番２号　日本電信電話株式会社内

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